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THE DIFFERENCES OF THE EFFECTS ON VO_2MAX-BASED RECOVERY METHOD OF POST-ANAEROBIC INTERVAL TRAINING TO LACTIC ACID LEVELS[i]

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Abstract:

This study aims to find out: (1) The differences of effects between recovery of contrast bath and pre neuromuscular facilitation methods of post-anaerobic interval training to lactic acid levels, (2) The differences in lactic acid levels between high VO_2max and low VO_2max, and (3) The effects on the interactions between recovery method and VO_2max to lactic acid levels. The sample was male students of basketball extracurricular SMAN 4 Surakarta collected using purposive random sampling techniques. The data were then analyzed using Two-way ANOVA at a significance level of 5%, as data obtained previously must meet the required tests which include normality test and homogeneity test. It can be concluded that (1) there are differences in the effect of recovery contrast bath method and PNF to the lactic acid levels. Recovery of contrast bath method has an average value of decreased lactic acid levels of 4.58, while stretching pre neuromuscular facilitation (PNF) method is 3.91. The hypothesis test indicates that Ho is rejected in which the value of P <α (0.00> 0.05) with $F_{observation}$ of 25.74. (2) There are differences in lactic acid levels between students who have high VO_2max and low VO_2max. The group with high VO_2max has an average value of 4.48, while the group with low VO_2max has an average value of 4.01. The hypothesis test of Ho is rejected in which the value of P <α (0.001> 0.05) with $F_{observation}$ of 12.74. (3) There is no interaction effects between recovery

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method using contrast bath and PNF with VO_2max in lactic acid levels, in which the hypothesis test of Ho is accepted with P value > α (0.57> 0.05) with $F_{observation}$ of 0.31.

Keywords: recovery, contrast bath, PNF, VO_2Max, anaerobic interval, lactic acid

1. Introduction

Physical training performed by a person has many benefits for body health. Everyone who perform the training correctly will get the benefits, such as the body becomes healthy, fit, and can improve performances. Astrand (1986) states that the regular, systematic, and continuous training, and is performed in a training program will improve physical capability significantly. In addition to the positive benefits, it also has negative impacts, e.g., lactic acid and free radical formation because training is a stressor for the body that can affect all systems (Costill, 2008).

The human body normally metabolizes to produce energy. One of the sources of human body movements is ATP, used for muscle movement (Guyton, 1986). The energy used during the activities in anaerobic conditions will produce side-products, such as lactic acid. It is normally present in the body and describes the condition of anaerobic glycolysis. It is also closely related to the ability of muscles to contract. The body has a number of limitations to tolerate lactic acid. Lactic acid levels will increase during the activities where the source of energy is derived from anaerobic glycolysis system. Lactic acid formation is the results of the activity of high intensity and long-term training. The presence of high activities without considering sufficient recovery time, can cause a buildup of lactic acid in blood that leads to the obstruction of the energy intake of the aerobic system in muscle cells and the onset of fatigue. Physical activity performed with maximum intensity can lead to the increased lactic acid levels in the blood and muscles (Fox, 1993).

The hoarding of lactate in blood becomes fundamental problems in physical performances since it causes chronic fatigue and decreases the physical performances. In competitive sports, such as basketball, athletes are sometimes faced with dense schedule of competition that will also result in the dense schedule of training. In such conditions, the trainer should be able to restore the condition of the athletes back to the state before the training or match to face the next match without experiencing significant fatigue. Observations made by the researchers show that the 30 male basketball athletes have an average lactic acid levels of 13.64 mmol / L after performing training. All the athletes have lactic acid levels at above 4 mmol/L (normal). Whereas in volleyball athletes, particularly 12 athletes after the match, have lactic acid levels at above 4 mmol / L with an average value of 13.2 mmol / L. Of the 12 athletes who have

lactic acid levels above the normal point, all athletes are undergoing fatigue. We can, thus, conclude that almost 100% of the athletes have above-normal lactic acid levels and fatigue after the match. Therefore, they need to have proper recovery to restore the lactic acid levels into the normal conditions after performing match or training.

VO_2max is body ability levels expressed in liters per minute or milliliters/kg/min weight. Every single cell needs oxygen to convert food energy into ATP (Adenosine Triphosphate) which is ready to be used for work. Most small cells consume oxygen is in a state of resting muscle, while the contracting muscle cells require a lot of ATP. As a result, the muscles used in training require more oxygen. Muscle cells need a lot of oxygen and produces CO_2. The need for oxygen and CO_2 production can be measured by a person's breathing. By measuring the amount of oxygen consumed during exercise, it can be seen the amount of oxygen used by the working muscles. The higher the amount of muscle used, the higher the needs for oxygen. Lactic acid is formed due to lack of oxygen in the muscle activity required. It can be concluded that the VO_2max affects the formation of one's lactic acid levels.

Fitness levels may be measured by the volume in consuming oxygen during maximum training. As commonly known, oxygen is the human main fuel needed by muscles in doing any heavy or light activities. The fatigue perceived by athletes will cause a decrease in levels so they will perform without prime levels to a game, then it can closely be ensured that they will be fail. The fast or slow fatigue by an athlete can be estimated from their aerobic capacity. Aerobic capacity indicates the maximum capacity of oxygen used by the body (VO_2max).

Fatigue highly affects the decline in of athletes' performances so that the achievements earned can also be decreased. Therefore, doing recovery becomes an appropriate way after performing training or match. This recovery phase is needed by the body to restore the body back to its initial state before performing training or match. There are many ways of recovery have been made to reduce fatigue, such as using static stretching, dynamic stretching and pre-neuromuscular facilitation (PNF). Post-exercise stretching will help to reduce muscle fatigue and pain associated with DOMS (Delayed Onset Muscle Soroness), but it also helps in the process of waste products including lactic acid. In the study conducted by Eskawida (2013), the results showed that there are significant differences between the type of dynamic stretching, static stretching, and PNF to the decreased lactic acid levels. PNF stretching has a change or a decrease in the lactic acid levels faster than dynamic and static stretching. This proves that the PNF stretching is more effective in reducing lactic acid levels compared to other types of stretching.

In addition to stretching, there are several methods that can be applied for the athletes to recover from fatigue as soon as possible so that they can re-show the best performances. A therapy using hot and cold water as the medium is known as contrast bath. Hot and cold water immersion will alternately cause vasoconstriction and vasodilatation that will make local blood circulation work better, improve the elasticity of the muscles and reduce muscle spasms (Cochrane, 2004). The increase of circulation will affect the smooth supply of oxygen and help the recycling of lactic acid into energy sources. The availability of energy back from the lactic acid will restore fatigue impacting on the prominent as the previous performances. Contrast bath has been used since long time ago in sports medicine to cope edema and the swelling due to injury, and this method is often used for recovery after performing training. Football medical team U-23 uses contrast bath method for the national team before competing with Morocco in Islamic Solidarity Match on September 22, 2013 in Palembang. This therapy is expected to help in accelerating the recovery of up to 80% of the of players' body fitness. It is an action taken to anticipate the dense schedule of medical team match, especially after competing in the semi-finals with Saudi Arabia (Kompas). Indonesian National Team (Timnas) U-19 also uses this hydrotherapy to restore fatigue after the match in the last few years. In fact, according to Aditya Prameswara (Physiotherapist League U-19), Frank Ribery also had to do it when defending French National Team at Euro 2008. It can be concluded that the contrast bath method is already popular in Indonesia, which is used as an alternative method of accelerating the recovery of a person's fitness in preparation for the training or next match.

Based on the background mentioned above, the researchers is aimed to examine "*The Differences of the Effects on Recovery Method of Post-Anaerobic Interval Training to Lactic Acid Levels based on VO_2max*"

2. Material & Method

This study was conducted in basketball field of SMAN 4 Surakarta, Jl. LU Adisucipto 1, Manahan, Surakarta, Central Java. The time was conducted in December 2016. This study used an experimental method with 2x2 factorial design. The sampling technique uses purposive random sampling. The sampling technique is determined by the criteria of VO_2max as well as certain inclusion and exclusion criteria. The data were collected by using MFT test for VO_2max and Accutrend plus for lactic acid levels. The data analysis used Two-way ANOVA at a significance level of 5%. The data obtained previously must meet pre-requisite test including normality test and homogeneity test.

The data were obtained from the measurement results to the attributive independent variables of the two groups, i.e., students who have high VO2max of the number of 16 samples was divided by 2 and each student was given recovery of contrast bath treatment and PNF method. The group of students who have low VO2max of the number of 16 samples was divided by 2 and each student was given recovery of contrast bath treatment and PNF method, respectively. Each group was given the test twice, i.e., once for pre-test once and the other for post-test. The test items on the pre-test and post-test were the same, i.e., lactic acid levels in blood.

3. Results

The data description of the analysis results on lactic acid level measurements in blood were conducted in accordance with the compared groups is presented as follows:

Table 1: The data description of measurement results on lactic acid levels in students who have high and low VO2max based on recovery method

VO_2Max	Treatment (Recovery)	Statistik	Pasca Latihan	Pasca Treatment	Penurunan Kadar Asam Laktat
Tinggi	Contrast Bath	Jumlah	113.8	74.9	38.9
		Mean	14.22	9.36	4.86
		SD	0.95	0.87	0.36
	PNF	Jumlah	114.40	81.50	32.90
		Mean	14.30	10.18	4.11
		SD	1.03	1.38	0.45
Rendah	Contrast Bath	Jumlah	123.90	89.40	34.50
		Mean	15.48	11.17	4.31
		SD	0.80	0.65	0.39
	PNF	Jumlah	122.50	92.80	29.70
		Mean	15.31	11.60	3.71
		SD	0.87	0.83	0.26

A. Group of recovery of contrast bath method has the average value of post-training at14.58 and post-treatment at 10.26 with the average value at 4.58 in the changes of blood lactic acid levels. In group of PNF recovery method has the average value of post-training at 14.80 and post-treatment at 10.89 with the average value at 3.91 in the changes of blood lactic acid levels. When the two treatments were compared to the average changes in levels of lactic acid in the blood with recovery methods contrast bath has a change or a decrease in lactic acid levels greater than PNF recovery methods.
B. The group of students with high VO2max has the average value of post-training at 14.26 and post-treatment at 9.77 with the average value at 4.48 in the changes of blood lactic acid levels. Whereas the group of students with low VO2max has the average value of post-training at 15.39 and post-treatment at 11.38 with the average value at 4.01

in the changes of blood lactic acid levels. If the two treatments are compared, then the group of students with high VO_2max has the change or decrease in lactic acid levels greater than the group of students with low VO2max.

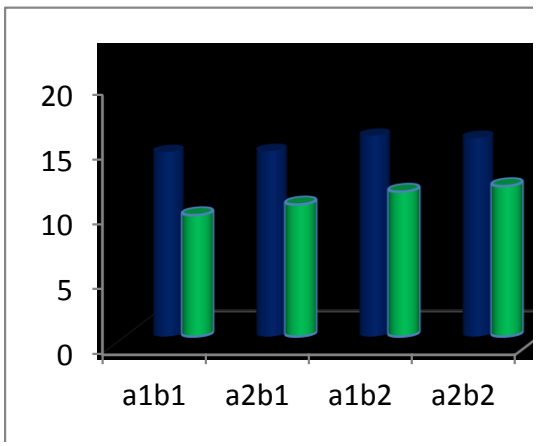

Figure 1: Comparative Histogram of the Average of Lactic Acid Levels in pre-test and post-test

Note:

a1b1: High VO2Max with contrast bath method
a2b1: High VO2Max with PNF method
a1b2: Low VO2Max with contrast bath method
a2b2: Low VO2Max with PNF method

Hypothesis test was conducted by Two-way ANAVA with significance level about 5%. Before the hypothesis test data obtained must meet the prerequisite test first, the test of normality and homogeneity test. Normality test results showed that the samples in this study with normal distribution and homogeneity of the results of the test showed that variants in samples in this study are homogeneous. Once the prerequisites are met analysis, and then proceed with the research hypothesis testing. Summary results of normality test, homogeneity, and hypothesis testing are as follows:

a) Normality Test

Table 2. One-Sample Kolmogorov-Smirnov Test

		penurunan
N		32
Normal Parameters[a,b]	Mean	4.2500
	Std. Deviation	.55241
Most Extreme Differences	Absolute	.099
	Positive	.081
	Negative	-.099
Test Statistic		.099
Asymp. Sig. (2-tailed)		.200[c,d]

From the previous table the normality test shows that the statistical value of Kolmogorov-Smirnov is 0.099 and sig. / P-value at 0.200. P> 0.05, therefore, means that the data reduction in lactic acid levels have normal distribution.

b. Homogeneity Test

Tabel 3: Levene's Test of Equality of Error Variances[a]

F	df1	df2	Sig.
.626	3	28	.604

From the previous table the homogeneity shows that the statistical value of sig. / P-value = 0604 is greater than 0.05, so that the data are homogeneous (P> 0.05)

c. Hypothesis Test

Hypothesis test is done to see if the null hypothesis (Ho) is accepted or rejected. It uses Two-way ANOVA techniques. This techniques is used to determine the differences in overall treatment effects including (1) the differences of recovery of contrast bath and PNF methods, (2) the differences in high and low VO_2max, and (3) the interaction between both methods (recovery and VO_2max)

Tabel 4. Tests of Between-Subjects Effects

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	5.495[a]	3	1.832	12.935	.000
Intercept	578.000	1	578.000	4081.715	.000
Metoderecovery (A)	3.645	1	3.645	25.740	.000
vo2max (B)	1.805	1	1.805	12.747	.001
Metoderecovery * vo_2max (A*B)	.045	1	.045	.318	.577
Error	3.965	28	.142		
Total	587.460	32			
Corrected Total	9.460	31			

Based on the previous table, it can be concluded as follows:

1. Fo (A) = 25.74 with sig. = 00:00 <0:05. Thus, the null hypothesis (Ho) is rejected. It means that there are significant differences between recovery of contrast bath and PNF methods to the changes in blood lactic acid levels.
2. Fo (B) = 12.74 with sig. = 0.001> 0.05. Thus, the null hypothesis (Ho) is rejected. It means that there are significant differences between high VO_2max and low VO_2max to the changes in lactic acid levels.

3. Fo (AB) = 0:31 with sig. 0:57 => 0.05. Thus, the null hypothesis (Ho) is accepted. It means that there are no significant interaction effects between recovery method and VO_2max in lactic acid levels.

4. Discussion

a. There are differences in the effect of recovery of contrast bath and PNF method to lactic acid levels after anaerobic interval training.

Recovery performed by contrast bath method can reduce lactic acid levels faster in post-anaerobic interval training. This method uses cold and warm water as the medium. The water exerts pressure on the body called hydrostatic pressure when it is being immersed. This pressure can cause the displacement of streams in the body from the extremities to the central cavity. Besides, the hydrostatic pressure also causes fluid from the intravascular to the extravascular move through the process of diffusion. Diffusion is the movement of molecules through the pores. Basically, fluid in the body will move from high levels to low levels. This fluid displacement can increase the substrate translocation of muscles, increase blood volume and is distributed to the central cavity, which in turn will increase the preload of the heart, stroke volume, cardiac output and blood flow throughout the body. These improvements will lead to increase of metabolism without expending additional energy.

Cold and warm water immersion will alternately cause the vasoconstriction and vasodilatation process. At the time of cold immersion, there is a process of vasoconstriction in the immersed area. It can decrease the cells for local metabolism, so as to assist in halting the metabolic waste in the form of lactic acid so that it will not be over accumulated. The immersion in cold temperature also causes the muscle temperature quickly back to the normal point and reduce muscle spasms.

During the warm water immersion, vasodilatation process will occur and launch the local blood flow, improves the elasticity of the muscles and reduce muscle spasms. Increased blood flow will also increase the amount of oxygen bound by hemoglobin in the blood. This process ensures the availability of oxygen, so the reduction of lactic acid as the waste products can be faster due to the presence of oxygen that will turn the lactic acid into pyruvic acid which then the pyruvate acid will enter the Krebs cycle and converted into energy.

From the figures generated in the data analysis, it shows that the ratio of the average change/reduction in blood lactic acid levels produced by recovery of contrast bath method is 4.58 greater than the PNF stretching.

b. There are differences in lactic acid levels between high and low VO_2max. VO_2max is one of the factors that can determine a person's capacity to perform intense exercise and is linked to aerobic endurance. VO_2max refers to the maximum amount of oxygen a person can take advantage of the training process with maximum stamina. At the time of physical activity, there is increased need for oxygen by the muscles being worked. Oxygen is used by the body to metabolize; the more oxygen is absorbed by the body showed the better performance of the muscles in the works so that substances which cause the remnants of exhaustion amount will be less. So the higher the VO_2max values a person, the less lactic acid levels were formed. The higher the VO_2max one has, the better the endurance / stamina them so that fatigue does not quickly occur.

VO_2max is one factor that is so dominant in the ability of the athlete's body. Aerobic capacity is essentially a big picture of the process of aerobic movement abilities of a person. Thus, a person will be a greater capacity to carry a heavy workload and a faster recovery after physical work if it has a high VO_2max. The use of maximal oxygen is a factor that determines the success of the appearance of resistance, namely the transportation and use of maximal oxygen carried by the muscles.

Also, VO_2max is a good indicator of aerobic endurance performance. Individuals who trained with a higher VO_2max will tend to execute better in endurance activities compared with those who had lower VO_2max for the aerobic endurance activity. In 1970, Kenneth Cooper examines the relationship between sport with physical fitness he found that people who possess high endurance for exercise, it turns out their lungs have the ability to accommodate 1.5 more air than ordinary people.

From the figures generated in the data analysis, it shows that the ratio of the average change/reduction in blood lactic acid levels in students with high VO_2max at 4.48 is greater than the group of students with low VO_2max.

c. There are no effects on the interaction between recovery method and VO_2max method in lactic acid levels.

The results show that the interaction between the recovery method and VO_2max method is not meaningful. This is evidenced from the sig. value received at $\alpha = 0.05$ by Two-way ANOVA calculation results is sig. = 0.57 > 0.5 (P-value> 0.05). In this study, the comparison of the two methods, both the students with high VO_2max and low VO_2max show the same value (both are best when being treated with contrast bath method).

5. Conclusion

Based on analysis of the data and the outline that has been done, it could be concluded that:

- There are differences in the effect of recovery contrast bath method and pre neuromuscular facilitation (PNF) after intervals anaerobic exercise to lactic acid levels. recovery contrast bath method was faster to decline lactic acid levels than pre neuromuscular facilitation (PNF)
- There are differences in lactic acid levels between students who have high VO_2max and low VO_2max. The decline of lactic acid levels to the students who has high VO_2Max was faster than the students who have low VO_2Max.
- There are no interaction effects between recovery method and VO_2Max to lactic acid levels.

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References

1. Astrand, P.O., Rodhal, K. (1986). Textbook of Work Physiology. New York.
2. Bompa, Tudor O. (1994). Theory and Methodology of Training. Kendall/Hant: Iowa of University.
3. Brukner, Khan. (2001). Alternating Hot And Cold Water Immersion For Athlete Recovery: A Review. Physical Therapy in Sport.
4. Budiwanto. S. (2008). Pengetahuan Dasar Melatih Olahraga. Malang: Jurusan Ilmu Keolahragaan FIP UM Universitas Negeri Malang.
5. Bucher, C.A. (1983) Foundations Physical Education and sport, (9th ed.). St Louis : The C.V. Mosby Company.
6. Cochrane. (2004). Effect of Contrast Water Theraphy Duration on Recovery of Cycling Performance; a dose – response. Study. European Journal Physiology.
7. Doewes, M., Furqon, M. (1999). Tes Kesegaran Jasmani Dengan Lari Multitahap. Surakarta: Puslitbang-Or Uns.

8. Foss, M.L. & Keteyian, S.J. (1998). Physiological Basic For Exercise and Sport. Dubuque: McGraw-Hill Companis.
9. Fox, Edward L. (1984). Sport Physiology. Holt W.B. Saunders Company.
10. Goodwin MA., Matthew L. (2007). Blood lactate Measurement and Analysis during Exercise: A Guide for Clinicians. Journal of Diabetes Science and Technology.
11. Guyton AC., Hall JE. (2014). Textbook of Medical Physiology. WB Saunders, Philadelphia.
12. Janssen, Peter G.J.M., (1987). Training Lactate Pulse Rate. Oule Finland: Polar Electro.
13. Kadir. (2015). Statistika Terapan. Jakarta: PT Raja Grafindo Persada.
14. Kisner, Colby. (2007). Therapeutic Exercise: Foundations and Techniques (5th ed.). Philadelphia: Davis Company.
15. McArdle, W.D., Katch, F.I. and Katch, V.L. (2001). Exercise Physiology: Energy, Nutrition, and Human Performance. Philadelphia: Lippincott Williams and Wilkins.
16. Mylsidayu, A., Kurniawan, F. (2015). Ilmu Kepelatihan Dasar. Bandung: Alfabeta.
17. Morton RH. (2007). Contrast Water Immersion hastens Plasma Lactate Decrease After Intense Anaerobic exercise. Journal Of Science And medicine in Sport.
18. National Council for Osteopathic Research. (2012). Contrast bathing- a snapshot summary report.
19. Willmore, H.J, and Costill, DL. (2005). Training for Sport and Activity The Physiological Basis of The Conditioning Process. USA: Wm, C. Brown Pulishers.